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VISION & NEEDS FOR DISTRIBUTED CONTROLS: CUSTOMERS FOR CONTROL SYSTEMS AND WHAT DO THEY VALUE (POSTPRINT)

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14. ABSTRACT
Distributed Engine Control Working Group: Coordinate, collaborate, and leverage integrated intelligent distributed (partially) engine controls and PHM technology development to address future and current requirements of both military and civil aviation. Provide an open forum for discussion and proliferation of primary S&T drivers and issues that are being, or should be, addressed. Identify possible transition paths for S&T products.

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Vision & Needs for Distributed Controls: Customers for Control Systems and What Do They Value

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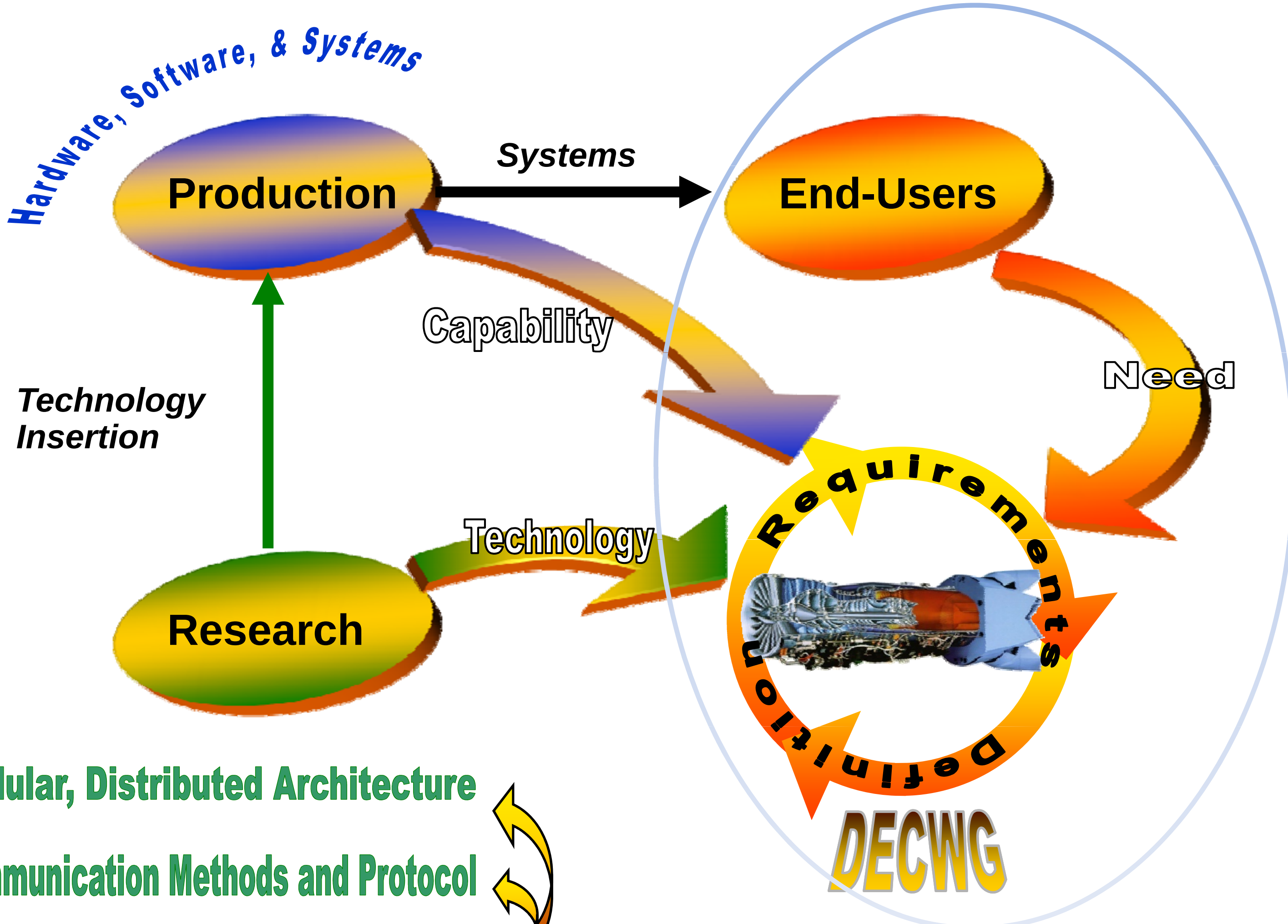
DECWG
Distributed Engine Control Working Group

The Process for Distributed Controls



Modular, Distributed Architecture

Communication Methods and Protocol

High Temperature Electronics

Objective: Modular, Open, Distributed Engine Control

Technology Benefits

- **Increased Performance**
  - Reduction in engine weight due to digital signaling, lower wire/connector count, reduced cooling need
  - 5% increase in thrust-to-weight ratio
- **Improved Mission Success**
  - System availability improvement due to automated fault isolation, reduced maintenance time, modular LRU
  - 10% increase in system availability
- **Lower Life Cycle Cost**
  - Reduced cycle time for design, manufacture, V&V
  - Reduced component and maintenance costs via cross-platform commonality, obsolescence mitigation
  - Flexible upgrade path through open interface standards

Capability Needs

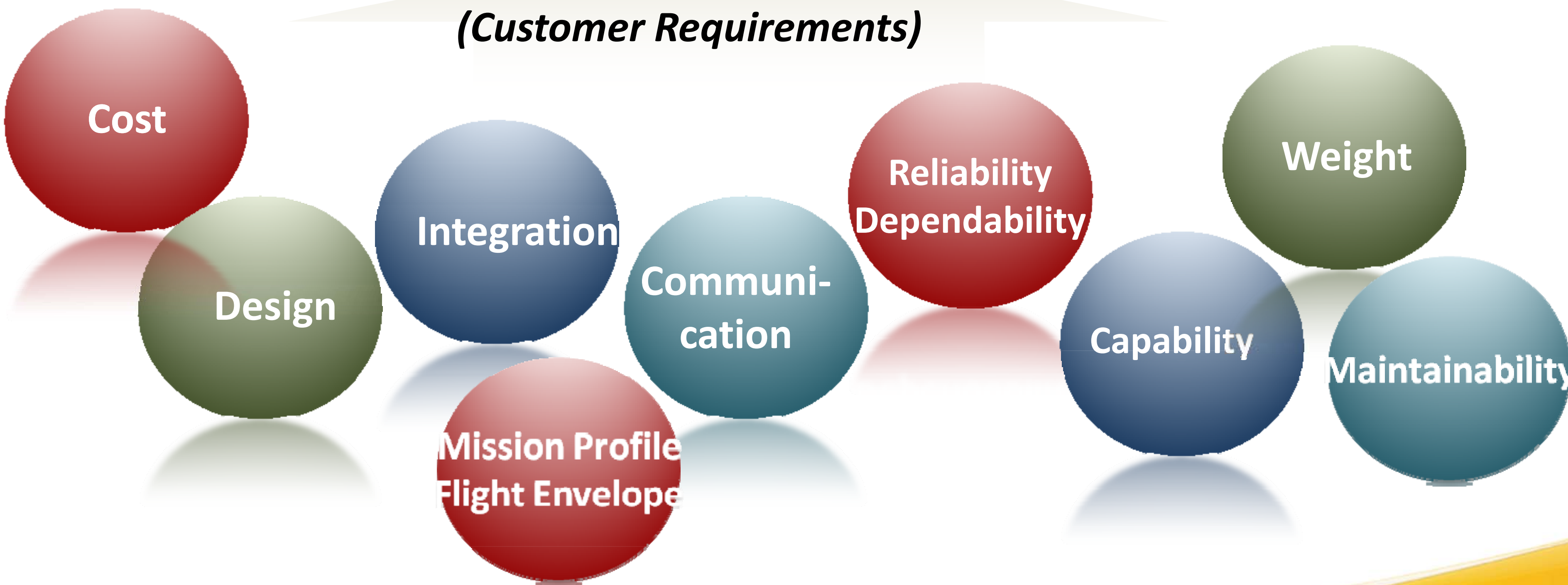
- **Open Systems Development, Modeling & Design**
  - Future systems requirements definition
  - Open industry interface standards definition
  - System modeling tools development
  - Modular system integration and test techniques
- **Hardware Systems Development**
  - High temperature integrated circuits and systems development
  - Improved electronic component availability
- **Software Systems Development**
  - Software system partitioning
  - Software design and modular test capability
  - Software distributed system V&V

Engine Manufacturer

There is a need for improved control devices that are compatible with the control electronics made by different manufactures. In addition there is a need for specific purpose control devices of one manufacturer to be compatible with more general-purpose control electronics from a different manufacturer.

adapt the system to your *needs*

(Customer Requirements)



Airframe Manufacturer

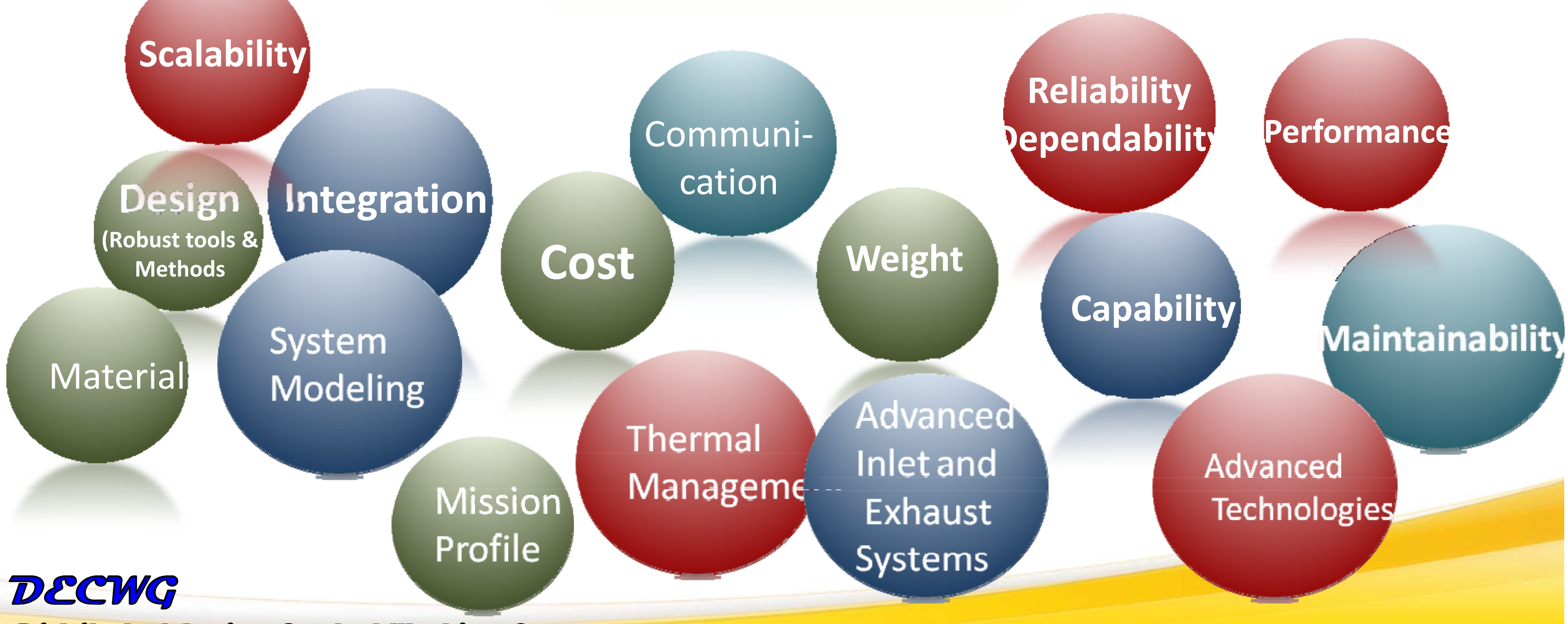
Mission Requirements, Vehicle Requirements , Customer /OEM Requirements

There is a need for control integration between engine , TMS, power, and the aircraft.

An iterative process to meet all requirements including customer and engine requirements

An integration Process with Interactive Approach,,,

Adapt the system to your customer's and OEM's *needs*



DECWG

Distributed Engine Control Working Group

Aircraft/Engine Owner

There is a need for improved autonomous control devices that are compatible with the control electronics made by different manufactures. The big issue is the cost and obsolescence
The A/C , engine owner s need to have the minimum cost of maintaining their asset

Adapt the system to your *needs at lowest cost*

Performing maintenance and repair on the flight line or in the depot will have reduced cost for a distributed control architecture, since any maintenance issues are easily identifiable.

Cost
(Development, production, maintenance)

Maintainability

Thrust/Weight

SFC

Reliability
Dependability

Capability

Performance

A set of user interfaces needs to be developed to allow a single user to efficiently control the fleet of aircraft. Their impact and benefit derive from the convergence of new DEC architectures

Comparison: Commercial vs. Military

- GE & P&W each build 500-1000 Jet engines annually and build replacement parts for 17000 engines
- Distributed control design will increase COTS, reduce inventories, and reduce cycle time for design, manufacture, V&V, and cost
- Military engines push the SOA technologies
- To maintain adequate military capabilities in the years ahead, the US will have to design, develop, and produce defense systems with the needed performance at more affordable costs
- Embedded military S/W for controls must handle enormously complicated integration tasks. DEC solution offers common S/W & H/W for both military & commercial engines
- To extend or change control system capability to handle complicated tasks, designers must modify the H/W, S/W, and improve fault tolerance and fail-safe operation
- S/W can implement functions that would be extraordinarily time-consuming & costly in H/W alone

Comparison: Large Engines vs. Small Engine

- Large engines and small engine classes have unique S/W H/W requirements
- The current commercial airline and military "bear market" is leading the "Big Four" to engage on more partnership and collaboration with each other and with small engine manufacturers
- The current military aircraft UAV procurement means more new development for the small turbine engine
- For the next several years, strengths in the turbine engines sector are expected to continue to come from increased military fighter aircraft and UAVs
- A DEC is the methodology to improve engine performance & cost
- In addition to manufacturer collaboration and R&D programs, several important market factors present challenges that are stimulating significant improvements in engine technology

Transition: Commercial vs. Military

Commercial to Military

• Military demand is growing for FADEC & control systems with expert system embedded in the S/W for fault tolerance

•Civilian demand has spurred rapid technological progress for commercial aircrafts

•Escalating procurement and fuel costs will stimulate the DoD to leverage commercial FADECs & control systems S/W & H/W.

•Modular / Universal/Distributed design can reduce development time and cost. S/W could offer baseline for military-qualified FADECs.

•To promote dual use, the services must recognize the similarities between commercial applications & military needs; too often, they focus on the differences

Military to Commercial

•Avionics has been the chief success story in transferring military S/W and hardware to civil sector. Through VAATE, and SBIR funding a lot of technologies has been transferred to commercial avionics.

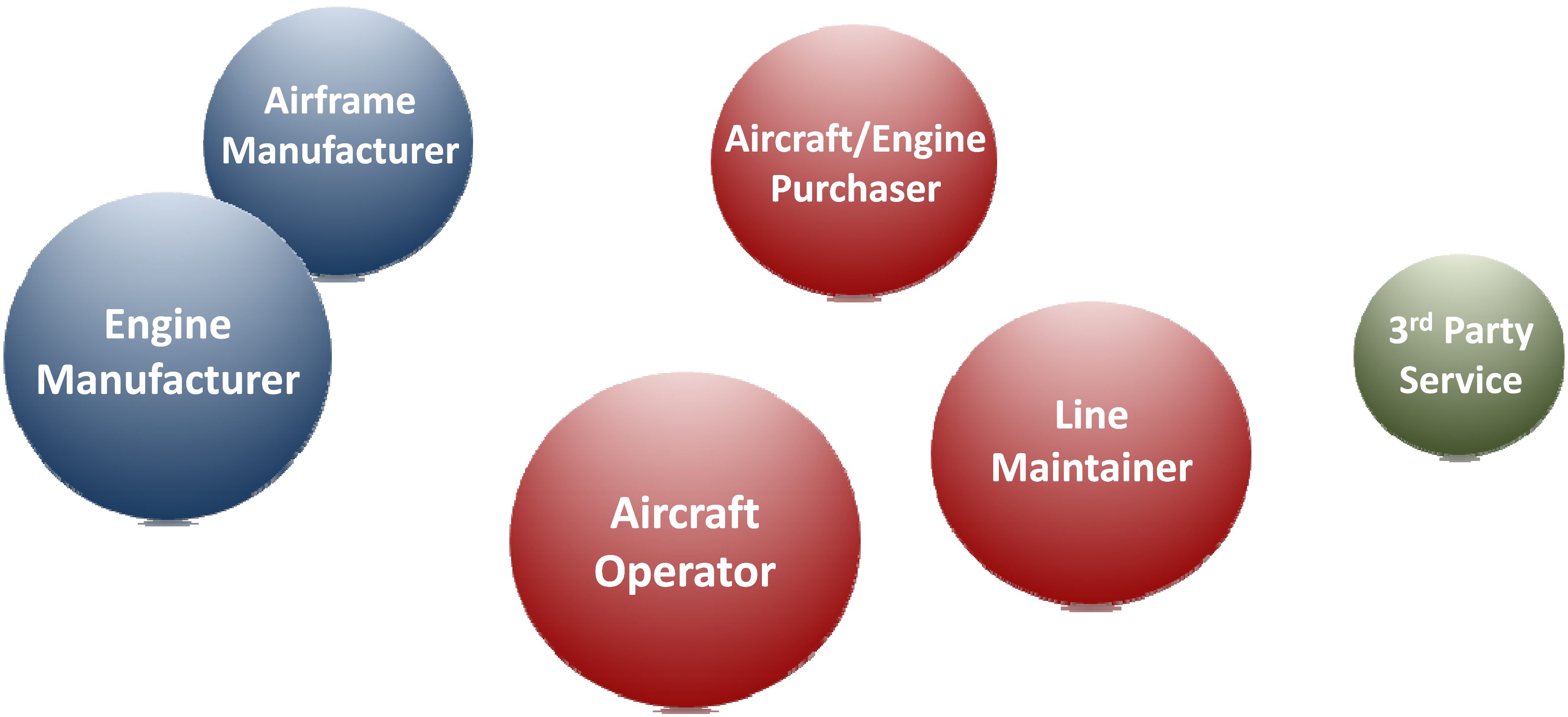
•Modeling & real-time SIMULATION can reduce integration cost for both commercial and military engine controls

•Technology transfer also occurs when on diverse programs from both commercial & military programs

Thank You!

BACKUP CHARTS

Who Is The Customer For Controls?



What Control Attributes Do Customers Value?

What Does "The Customer" Value?

Engine: Pays Cost of FADEC Development/Production
FADEC Weight / Size Impacts Engine Design

Airframe: FADEC Impacts Aircraft Capability / Integration

Manufacturers

Operational Costs

Marketability

Aircraft/Engine Purchaser: Responsible for FADEC Repair Cost

Aircraft Operator: Impact of Failures i.e. Delays/Cancellations

Line Maintainer: Labor/Materials FADEC Troubleshooting & Repair

Typically Airlines

Transfer Risk

3rd Party Service Providers: Pay for FADEC Repair & Impact to Airline

Weighting of Values Vary By Engine Application

Purchase Cost / Weight Increasingly Valued As Engine Size Decreases

Control System As Percentage of Total Engine Weight/Cost

Engine Manufacturer Values Often Transfer to Military Customers

DoD Owns Engine Design – Often Responsible for Development / Production Costs

Reliability Even More Critical for Smaller Airline Fleets

Fewer Aircraft Means Fewer Options When One is Down for Maintenance

How Can FADEC Impact Customer Value?

Reduce Overall Control System Weight

Consider Electronics, Power Supplies, Housings, Connectors, Harnesses, etc.

Enable Reuse and Upgradability of FADEC Components

Provide Headstart on FADEC For New Applications

Improved Control System Component Reliability

Robustness Against Steady and Cyclical Temperature and Vibrational Effects

Easier Control System Troubleshooting and Repair

Reduced Training and Labor Hours via Automation